The Elemental Analysis of Glass Beads
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Simple blue (IIa40) beads from 17th century Mission Santa Catalina de Guale: Dating, origins, and elemental composition

Elliot H. Blair¹ and Laure Dussubieux²

1. Introduction

Opaque, drawn, turquoise-colored glass beads of simple construction, identified as Kidd and Kidd (2012 [1970]) IIa40 are one of the most ubiquitous types found on colonial sites in eastern North America. As noted by Francis (2009a), this ubiquity has resulted in numerous names used to refer to this bead variety, including Early Blue (Heisey and Witmer 1962), Estaufa Blue (Whiththoft 1966), Jamestown Blue (Whiththoft 1966), Childersburg Opaque Blue (Penman 1972, Dejarnette and Hansen 1960), Sugarcane Blue, Ichtucknee Plain (Goggin, n.d.), and Ichtucknee Blue (Deagan 1987). In part because of the ubiquity of this type, numerous compositional studies have been conducted, addressing questions of temporality and manufacturing source (e.g., Hancock et al. 1994; Kenyon et al. 1995; Hancock et al. 1996; Walder 2018). In this chapter we discuss the results of LA-ICP-MS analysis of twenty type IIa40 beads recovered from 17th century Mission Santa Catalina de Guale (SCDG), St. Catherines Island, GA, considering the temporality and origins of these artifacts.

2. Type IIa40 beads: Characteristics, origins, and chemistry

2.1. Characteristics

Despite the ubiquity of IIa40 beads on colonial sites in the Americas, the type has been the subject of limited direct inquiry (aside from compositional analysis). The most extensive discussion of the type has been by Francis (2009a), who makes a number of keen assertions and provocative hypotheses. While many studies note that this bead type is drawn, simple, turquoise blue, and often manufactured of

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unstable, leached, glass—Francis highlights two additional important attributes of this type.

First, many specimens of this variety exhibit the characteristic imperfections of the a speo rounding process, a method in which cut segments of bead cane are rounded by being reheated using a multi-pronged spit (Karklins 1993). This finishing technique—often resulting in conjoined beads and broken projections from the ends of the beads—was utilized by members of the Venetian Paternostri bead making guild and its expatriate members (Francis 2009a, b). Beads made using this technique are in many cases distinguishable from beads manufactured by the Venetian Margareteri guild, which used the a ferrazza finishing technique (stirring the cut segments over heat), and from beads rounded using the later, “hot-tumbling,” method that used a rotating drum developed ca. 1817 (Figure 4.1).

![Fig. 4.1: A IIa40 bead recovered from Mission Santa Catalina de Guale, exhibiting the characteristic air bubbles of the type and conjoined due to the a speo manufacturing process.](image)

The second attribute that Francis (2009a) discusses is the striated appearance of this type. He noted that many early descriptions of these beads note this characteristic, describing the striations as air holes or bubbles (Watt and Meroney 1937; Duffield and Jelks 1961), or having “a texture reminiscent of stripped sugarcane” (Harris et al. 1965; Harris and Harris 1967, 1973; Harris et al. 1999). He attributed this characteristic to the use of low-quality ingredients and poor production methods. He also suggested that—based on priority and descriptiveness—the type be referred to as “Bubble Glass Beads,” rather than one of the other innumerable names used for the type.

In addition to noting these attributes for the type, Francis (2009a) also suggested that the type was likely correlated with the turquí beads of the Spanish cargo lists (Torre Revello 1943; Kelly 1992). While he notes that this descriptor could refer to color, it more likely indicates an erroneous assumption that the bead
Simple blue (IIa40) beads from 17th century Mission Santa Catalina de Guale type may have derived from Turkey. In fact, not all varieties identified as turquí in the Spanish cargo lists were blue; black, green, clear, and golden varieties of turquí were also identified (Kelly 1992; Francis 2009a).

2.2. The French connection

Based on these observations, Francis (2009a) made the provocative hypothesis that “Bubble Glass Beads” of all colors, including the IIa40 blue variety, were likely manufactured in France. He dismisses Venice as a possibility based on the poor-quality of the glass and Amsterdam based on the absence of the type in comparative samples (e.g., Karklins 1974, 1983, 1985; van der Sleen 1962, 1963a, b; van der Made 1976; Gawronski et al. 2010; Hulst et al. 2012). He supported this suggestion by arguing that historical documentation indicates that during the 16th century France was recruiting glass makers and beadmakers from Venice—primarily represented by members of the Venetian Paternostri guild, the guild responsible for the manufacture of the a speo finished type IIa40 beads. Francis deduced from these two points that Paternostri produced beads manufactured from low quality glass must be a product of the documented French industry, rather than the products of the better-established Venetian or Dutch industries.

This conclusion was also supported by Turgeon’s (2001) analysis of French notarial archives, which showed that France was a major producer of glass beads during the late 16th and early 17th centuries. Additionally—paralleling Francis’s conclusions—Turgeon (2001) notes that “turquin” was a specific category of glass bead manufactured in France, arguing that they were “undoubtedly the round turquoise beads, IIa40 in the Kidd classification… [and] are in a category of their own, perhaps because of the very particular chemical makeup of these beads.”

This attribution of type IIa40 beads to French manufacture was initially met with some skepticism. In the years since this hypothesis was first proffered, however, some supportive evidence has emerged and a number of researchers have argued for a robust French industry (e.g., Walthall 2015). Dussubieux (2009; Dussubieux and Gratuze 2012) has reported compositional data on glass beads and ornaments manufactured and/or excavated from several sites in France, and recently, Karklins and Bonneau (2019) have reported on an assemblage of early 17th century beads and beadmaking wasters that were recovered from a site in Rouen. Much of this material shows evidence of the a speo finishing technique and a number of IIa40 beads—containing numerous “bubbles”—were included in the assemblage. Similarly, Loewen (2019), using primarily documentary evidence, argues for extensive 16th and 17th century glass bead industries in Normandy and Rouen and suggests that France was the likely source for most beads recovered from early 17th century northeastern North American sites.
In a recent, controversial paper, Kunz and Mills (2021) report ten IIa40 beads recovered from three late precontact sites in Alaska. Based on some equivocal radiocarbon dates, they argue that this bead type may have been manufactured in Venice as early as the 15th century. Nevertheless, all historical and archaeological evidence indicates that this bead type was not manufactured earlier than ca. 1560 (Blair 2021).

2.3. Compositional analyses of IIa40 beads

Because of their ubiquity on North American sites, Kidd and Kidd IIa40 beads have also been subjected to more compositional studies than almost any other bead variety in the colonial Americas. Following several early analyses that included small numbers of this type (Davison and Harris 1974; Karklins 1983; Lewis 1979; Chafe et al. 1986), the first extensive analyses were reported by Hancock et al. (1994). Using Instrumental Neutron Activation Analysis (INAA), Hancock and colleagues analyzed samples of blue beads from the Great Lakes that had been previously assigned to the stylistically defined Glass bead Periods I (~CE 1580 – 1600), II (~1600-1620), and III (~CE 1620 – 50) (Kenyon and Kenyon 1983, Fitzgerald 1990, Fitzgerald et al. 1995). Their key finding was that 16th century IIa40 beads tended to have lower sodium, calcium, and chlorine and higher copper than 17th century specimens. They also noted a lack of antimony, while tin was present in a number of specimens. This analysis was supplemented by several later reports (e.g., Kenyon et al. 1995; Hancock et al. 1996) that expanded the sample temporally and regionally and found that quantities of calcium, potassium, sodium, chlorine, copper can be used to segregate bead assemblages from the 16th through early 20th centuries (Kenyon et al. 1995).

Additionally, some have suggested that the hypothesized temporal patterning observed by Hancock and his colleagues might instead reflect changes in bead suppliers. Fitzgerald et al. (1995) suggest that the high copper content of the late 16th century beads reflects Basque supplied products of a Southern European industry while the low copper beads are the French-supplied products manufactured in France or, perhaps, Amsterdam.

Hancock and colleagues have also conducted a series of analyses of beads of different colors. Importantly, their work on white glass beads identified a chronological sequence of glass opacifiers where early beads (16th and early 17th centuries) were opacified with lead-tin, calcium antimonate was used starting during the late 17th century, and arsenic based opacifiers were used during the 18th and 19th centuries (Hancock et al. 1997; Hancock et al. 1999; Sempowski et al. 2000; Moreau et al. 2002; Moreau et al. 2006).
In the Upper Great Lakes region, Walder (2013, 2015, 2018) has also identified a number of temporally significant compositional groups for simple drawn, turquoise blue beads. Most notably, these include several 17th century groups characterized by a high zinc content, and a transition from high Mg and low P, to the reverse, around ca. CE 1700. Walder (2018) also documented increasing CaO over time in the Great Lakes region. Extensive analyses of type IIa40 beads dating from the 16th-18th centuries in East Tennessee have also been conducted by Dalton-Carriger and Blair, primarily using x-ray fluorescence spectrometry (XRF) and focusing on patterns in opacifier use (Dalton-Carriger and Blair 2015; Blair et al. 2017).

3. Mission Santa Catalina de Guale

3.1. The site

Thousands of type IIa40 beads have been recovered from colonial sites in the Southeastern United States (e.g., Lapham 2001; Brain 1979), including at 17th century Mission Santa Catalina de Guale, the location of one of the largest and most diverse bead assemblages documented from a Spanish colonial site (Blair et al. 2009).

The Guale people of the northern Georgia coast had one of the earliest and longest histories of sustained European contact of any native group in North America (Thompson and Worth 2011). This included a series of early encounters during the 16th century (Lyon 1976; Hoffman 2002, 1990; Worth 2009a, 2015; Jones 1978), and in 1587 the primary Franciscan Mission Period in La Florida began. By 1595 two Franciscans were stationed on the island of Guale (St. Catherines Island, Georgia) and additional missions were also established throughout the province. Two years later, however, five of the six friars stationed in the province were killed during the 1597 Guale rebellion and most of the coastal missions were destroyed (Francis and Kole 2011). Following the resolution of the revolt, friars were once again distributed among native villages of the North Georgia coast beginning in 1605, initiating a sustained 75-year period of missionization on St. Catherines Island and only ending in 1680 following slave raids by the British-allied Westos (Worth 1995; Bowne 2005; Worth 2009b).

Since the mid-1970s, significant archaeological work has been conducted at Mission Santa Catalina (Thomas 1987, 1988, 1993, 2009; Larsen 1990; Reitz et al. 2010; Blair 2015b; Blair et al. 2009). The bulk of the excavations have occurred within the central compound of the mission, including the excavation of the mission church, cemetery, friary, kitchen, and two wells, as well as more
limited excavations within the Native residential sector. These excavations have been well described by Thomas (1987, 1988, 1993, 2009, 2010, 2011), and further publications on this material are currently in preparation at the American Museum of Natural History.

Excavation of the mission cemetery, located beneath the floor of the church and containing a minimum of 431 individuals, has also provided considerable information on the biocultural and bioarchaeological makeup of the mission population (Schoeninger et al. 1990; Larsen 1990; Stojanowski 2005). Found with these individuals were numerous grave goods, including crosses, devotional medals, religious medallions, majolica vessels, bells, mirrors, rings, stone discoidal objects, and an engraved shell gorget with a coiled rattlesnake motif (Thomas 1988; Blair et al. 2009; Winkler et al. 2017). Additionally, the great majority of the almost 70,000 beads recovered from Mission Santa Catalina were found interred in the church cemetery.

3.2. The beads of Mission Santa Catalina de Guale

The bead assemblage from SCDG has been extensively described elsewhere (Blair et al. 2009) and primarily includes specimens manufactured from glass, but also includes jet, amber, carnelian, and rock crystal specimens. These objects were manufactured around the globe, likely including Venice, Amsterdam, France, Spain, Bohemia, China, India, and the Baltic region, and numerous publications have leveraged the size and diversity of this assemblage to explore questions of bead origins, chronology, manufacture, exchange, and social networks (Blair et al. 2009; Blair 2015a, b, 2016, 2017a, b).

Despite the extreme diversity found within this assemblage, including the presence of numerous rare varieties of molded, segmented, and blown beads, one of the most interesting and abundant types in the assemblage is the drawn, simple, turquoise blue Kidd and Kidd (2012[1970]) IIa40 bead. Comprising about 7.6% of the assemblage, the 5,265 whole and fragmentary specimens of this type were distributed across all contexts at the site.

4. Analysis of SCDG IIa40 beads – materials and methods

Twenty type IIa40 beads from burial contexts at Mission Santa Catalina de Guale were analyzed in 2014 using LA-ICP-MS at the Elemental Analysis Facility of the Field Museum of Natural History using the standard analytical protocols of that laboratory (see Annex A). This sample was chosen to include ten beads from early 17th century burials and ten beads from late 17th century burials (Table 4.1). The dating of these assemblages was based on the presence of temporally
significant opacifiers found in white beads in these same assemblages (Blair 2017b), the presence of temporally diagnostic bead types (see Smith 1983, 1987), and stratigraphic relationships between burials.

<table>
<thead>
<tr>
<th>Context</th>
<th>IIa40 beads sampled</th>
<th>Date</th>
<th>Temporal Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burial A</td>
<td>5</td>
<td>Early 17th century</td>
<td>Stratigraphy</td>
</tr>
<tr>
<td>Individual 90</td>
<td>2</td>
<td>Late 17th century</td>
<td>50 white beads, analyzed with XRF, opacified with Sb</td>
</tr>
<tr>
<td>Individual 102</td>
<td>1</td>
<td>Late 17th century</td>
<td>51 white beads, analyzed with XRF, opacified with Sb</td>
</tr>
<tr>
<td>Individual 134</td>
<td>1</td>
<td>Late 17th century</td>
<td>1 white bead, analyzed with XRF, opacified with Sb</td>
</tr>
<tr>
<td>Individual 139/140</td>
<td>1</td>
<td>Late 17th century</td>
<td>17 white beads, analyzed with XRF, opacified with Sb</td>
</tr>
<tr>
<td>Individual 238</td>
<td>5</td>
<td>Late 17th century</td>
<td>15 white beads, analyzed with XRF, opacified with Sb</td>
</tr>
<tr>
<td>Individual 318</td>
<td>5</td>
<td>Early 17th century</td>
<td>30 white beads, analyzed with XRF, opacified with Pb-Sn. Numerous pre-ca. 1630</td>
</tr>
</tbody>
</table>

Table 4.1: SCDG IIa40 bead sample analyzed by LA-ICP-MS

5. Results and discussion

5.1. Chronology

Supplemental Table S4.1 reports the full LA-ICP-MS results for the IIa40 beads analyzed from Mission Santa Catalina de Guale. As expected, all beads were manufactured from a soda-lime-silica glass, typical of most post-medieval European drawn glass beads (drawn Bohemian beads, dating to the 19th century, are a noted exception), and copper served as the primary colorant. All the beads also have small quantities of tin (115 – 4076 ppm) and lead (112 – 3536 ppm), while lacking any significant quantity of antimony (1 – 36 ppm). Initially we had hoped that the presence or absence of these ingredients might segregate the SCDG IIa40 bead population into two temporal groups, as is possible with opaque white (Blair 2017b) and black (Templin and Blair 2016; Templin 2017) beads. It seems, however, that for turquoise blue beads this elemental shift occurs at a later date (Dalton-Carriger and Blair 2015; Blair et al. 2017; Blair et al. 2021), post ca. 1680.
Additionally, while the dating of the SCDG burial contexts is relatively secure, few of the temporal markers identified by Hancock and colleagues seem to be particularly useful in distinguishing the early 17th century specimens from the late. For example, Figure 4.2 shows a sodium/calcium biplot of the SCDG samples overlaid on data reported by Hancock and colleagues (Hancock et al. 1994; Kenyon et al. 1995) for beads dating 1580-1760. While none of the SCDG beads match the 16th century recipe, further divisions within the 17th century are not apparent.

Potassium content, however, does appear to possibly serve as a temporal marker between the early and late 17th century specimens. Figure 4.3, a biplot of soda and potash, indicates two distinct groups (and a single bead, 28.1/4345.0001, with very low soda content caused by glass corrosion and leaching), with most of the late 17th century specimens distinguished by having greater than 4% potash, and those dating to the early 17th century having less than 2.6% K₂O. While this is a limited sample size, and might reflect variation between the products of specific glass houses or batches of glass, Kenyon et al. (1995) found a similar increase in potassium content through time, noting that potassium content increases to greater than 4% during the 1760-1840 period in Ontario.

![Fig. 4.2: Bivariate plot of Na and Ca elemental weight percent. Data for Ila40 compositions compiled from Hancock et al. (1994) and Kenyon et al. (1995), with 95% confidence intervals, are shown for 1580-1600 (orange), 1600-1620 (pink), 1620-1650 (green), and 1670-1760 (red). Early 17th century SCDG Ila40 beads are marked by asterisks, and late 17th century SCDG Ila40 beads are marked with squares.](image)
Fig. 4.3: $\text{Na}_2\text{O}$ and $\text{K}_2\text{O}$ biplot of Mission Santa Catalina IIa40 beads.

Similar patterning is also evident in several of the trace elements—notably B and Rb (Figure 4.4)—with boron elevated among the late 17th century specimens and rubidium elevated among the early specimens. This patterning is unsurprising because these elements are often associated with potassium content (Henderson 2013), and Moretti and Hreglich (2013) also note that the use of boron containing compounds is documented in late 17th century Venetian recipe books.

The temporal patterning of the IIa40 beads from Santa Catalina, however, is also confounded by several beads recovered with late 17th century burials (i.e., Individuals 90 and 102) plotting with the early 17th century samples. A closer look at the archaeological context for both of these individuals suggests that this is likely due to either heirlooming of some beads or the disturbance of earlier bead assemblages by later burials. For example, Individual 90 was found buried with more than 2,000 seed beads, that during excavation appeared to have been arranged as necklace strands lying across this individual’s chest and neck (Blair 2009). Previous XRF analysis of 50 white beads revealed that they had all been opacified with calcium-antimonate, a late 17th century glass opacifier (Blair 2017b; Sempowski et al. 2000; Moretti and Hreglich 2005). Only 20 of the more than 2,000 beads found with this individual were larger beads, and the two analyzed IIa40 beads were the only two of this variety. The relative uniqueness of these beads with this burial suggest a different mode of acquisition. Heirlooming is certainly a possibility. An alternative possibility is that these anomalous
larger beads may have been originally associated with an earlier burial and were disturbed and then redeposited during the later interment of Individual 90. Such disturbance was quite common in the Mission Santa Catalina cemetery (Blair et al. 2009, Thomas 1988). This latter explanation most likely accounts for the earlier bead associated with Individual 102, where several beads were likely redeposited from an adjacent, earlier, burial (Blair 2009).

5.2. Manufacturing source

Besides chronology, the other main goal in analyzing the IIa40 beads from Mission Santa Catalina was to evaluate Peter Francis’s (2009a) hypothesis of French origin for the SCDG IIa40 beads. While little comparative data exists for French glass used in bead manufacture, Dussubieux (2009) analyzed 28 samples of glass ornaments from Rouen, France and compared those items to the composition of material recovered from Dutch factories (Karklins et al. 2001, 2002). In her analysis, Dussubieux (2009) identified three compositional groups within the Dutch and French material, defined by relative percentages of potash, soda, and lime. Figure 4.5 is a ternary diagram illustrating the three groups, with the SCDG IIa40 beads, Dussubieux’s samples of turquoise blue glass from Rouen, and Karklins et al.’s (2001; 2002) samples of Dutch turquoise blue glass plotted. Three interesting observations can be made from this diagram. First, all early
17th century IIa40 beads from SCDG, as well as several of the late 17th century specimens (i.e., the intrusive or heirloom IIa40 beads interred with Individuals 90 and 102), fall within Dussubieux’s (2009) group 1. This group, characterized by low lime, low potash, and high soda, primarily includes specimens of turquoise blue glass manufactured in Amsterdam. Second, none of the SCDG specimens fall within Dussubieux’s group 3, which included most of the turquoise blue glass manufactured in Rouen. Finally, most of the late 17th century SCDG IIa40 beads do not fall within any of Dussubieux’s (2009) compositional groups, suggesting a different place of manufacture.

Fig. 4.5: Ternary diagram of soda, potash, and lime showing elemental groupings identified by Dussubieux (2009). Analyses of the SCDG material and French (Dussubieux 2009) and Dutch (Karklins et al. 2001; 2002) turquoise blue glass are plotted.

6. Conclusion and discussion

Analysis of a limited sample of type IIa40 beads from well-dated contexts at 17th century Mission Santa Catalina de Guale has yielded several important observations about the temporal dimensions and manufacturing sources of type IIa40 beads circulating in colonial North America during the 17th century. First, the transition from lead-tin to calcium antimonate opacified beads that occurred during the mid-17th century for both opaque white (Blair 2017b; Sempowski et al.
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2000) and manganese-colored black (Templin 2017) beads does not seem to have simultaneously occurred for opaque turquoise blue beads. For this type, a post ca. 1680 date is more likely to mark this transition, which is unfortunately too late to be useful for dating purposes at Mission Santa Catalina.

Second, the elemental markers defined by Hancock and colleagues (Hancock et al. 1994; Kenyon et al. 1995; Hancock 2005, 2013) as being useful for segregating turquoise blue beads in Northeastern North America by temporal periods do not appear to be particularly useful in the Southeastern United States. This could be due to beads being supplied from different manufacturing centers, variation in intra-regional glass house production practices, the limited suite of elements analyzed by INAA, or the use of “the site,” rather than short duration contexts (e.g., burials), as the analytical unit underpinning the sequence (see discussion in Marcoux 2012). Despite the inapplicability of the Northeastern sequence to Mission Santa Catalina, limited evidence suggests that potassium, boron, and rubidium content might be good temporal indicators during the 17th century. Alternatively, these might be markers of specific glass batches or glass house production practices.

Finally, the limited comparative data for 17th century French manufactured beads and ornaments (Dussubieux 2009) does not support Francis’s (2009a) hypothesis for a French origin for the SCDG IIa40 beads. Instead, Francis may have been too hasty in his rejection of a Dutch source for this type. While he suggested that IIa40 varieties have not been identified in Dutch collections, Karklins (1974) did in fact identify a number of varieties that are described as having “abundant linear bubbles in the glass”. This includes, for example, a IIa31 specimen, distinguished from IIa40 beads discussed here only by being transparent and a slightly different shade of blue. More recently, Bradley (2014) has identified a number of IIa40 specimens excavated from a 17th century Dutch factory, and he makes a strong case that many beads of this type found in Northeastern North America may have been manufactured in Amsterdam, particularly at the Carel-Soop glasshouse. Comparison with the Dutch compositional data compiled by Dussubieux (2009; see also Karklins et al. 2001, 2002) indicates that the early 17th century SCDG IIa40 beads have compositions that are consistent with Dutch origin. The late 17th century SCDG IIa40 beads match neither the French nor the Dutch comparative material, so perhaps Venice is the likely source for these items. These attributions, of course, are only tentative, because as Dussubieux (2009) points out, we still have very limited comparative data from France and virtually none from Venice.

Even with a small sample size, compositional analysis of these SCDG IIa40 beads is yielding important insights about the colonial bead trade in North America. Future work, with increased sample sizes, additional interregional
comparisons, and the acquisition of new comparative material from additional European manufacturing centers only promises to increase the potential benefits of this approach.

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